W. G. Smith.
Leeds. 1847

SOME ACCOUNT

OF THE

ANIMAL,

VEGETABLE AND MINERAL

KINGDOMS;

WRITTEN FOR HER OWN CHILDREN.

BY MRS.

LONDON:
LIONEL BOOTH, DUKE STREET, PORTLAND PLACE.
1848.

J. Bradley, Printer, 78, Great Titchfield-street, Marylebone.

CONTENTS.

PREFACE.

The following little Work was commenced with a view of preparing a short Lecture for my Children, and was intended to be read to them in the Christmas holidays 1846. Circumstances, however, prevented our meeting; and being compelled to pass the greater part of that winter alone, I found the task I had commenced so pleasing and instructive *to myself*, that I continued writing until there became sufficient to make this small Volume, which being printed, may perhaps prove acceptable to

other young folks, as well as to those for whom it was originally intended.

Probably little that is new will be found in these pages: all that they contain may be met with in other Books, even in such as have been expressly written for Children; but young persons can learn nothing effectually without frequent repetition, and the same sentiment, if *good* and *true*, will surely bear telling again and again; hence it is more likely to be remembered.

As it rarely happens that men of Science, whose time is employed in abstruse researches, have either the leisure or the inclination to accommodate *their minds* to the capacities of children, the task of disseminating the knowledge which they

have acquired devolves upon others who are able and willing to undertake it; this is a duty more particularly suited to a mother, whose happiness depends almost entirely on the virtuous disposition of her children, and the proper cultivation of those intellects which the Almighty has committed to her care and guidance.

It is in the early and important days of childhood that the tender guardianship of a mother is most valuable, and the seeds then sown frequently take the deepest root, and exert their influence throughout life; for

> "Youth, like softened wax, with ease will take
> Those images which first impressions make.
> Should they be fair, their actions will be bright;
> If foul, they'll clouded be like shades of night."

CHAPTER I.

MY DEAR CHILDREN,

I AM going to talk to you about the wonderful works of God, and the numberless ways in which he evinces his wisdom and consideration for the happiness and well-being of his creatures.

He has endowed mankind with a power of reason greatly superior to the instinct of other animals. This enables us not only to learn and appreciate the true and beautiful arrangements in nature, but also to increase that knowledge which affords us the power of adapting the

materials furnished by our globe, to the preservation and enjoyment of animal life.

All that you will read in the following pages is gathered from valuable books, intelligent lectures, and delightful conversations. As the mother bird flies from her nest at convenient times to procure nourishment for her young, and brings it home grain by grain for the support of her little family; even so have I left you, peacefully sleeping on your pillows, while I went in search of knowledge, and have thus laid up a little store for your use, which will at least serve until you are able to go abroad and seek it for yourselves, and may till then afford you amusement and instruction.

The various things which God has created, we divide into three classes, and call them the animal, vegetable and mineral kingdoms.

From these three classes we supply all the wants, comforts, and luxuries of life; they are equally useful for food, medicine and clothing. Every day we eat meat, vegetable and salt; we are dressed in leather and silk, cotton and metal: these are first created according to the laws of nature, and we afterwards convert them by various preparations to our use, ornament and convenience.

The animal when living is not fit for food, nor is its skin ready for shoes, or its wool and hair for weaving into cloth—the vegetable

as it grows offers us neither sugar nor oil, nor is its cotton or linen ready for spinning—a lump of metal of itself gives no colour for dyeing, nor is it ever found in a condition for medicine! What then is required to be done in order to render them useful? Wise men have from time to time discovered and taught us how all these things should be prepared for our use, and the science which teaches them is called chemistry.

Everything this world produces is found in one or other of the three following states; namely, solid, liquid, and aëriform; and each may be changed from one state to the other by different degrees of pressure, heat or cold. A good ex-

ample of this is water; everybody knows it in each of its three states, as ice the solid, water the liquid, and steam the aëriform, severe cold being necessary to produce the first, moderate warmth the second, and a greater degree of heat the last.

Steam is invisible, it is only on mixing with the air, and becoming cooled, that it appears like a cloud, which is in reality the steam returning to water; this you know to be the case by having frequently held a cold spoon close to the spout of a tea kettle while boiling, and finding it soon covered with water like a dew. All this you will say we easily understand with respect to water, but how can stone, metal, and wood become liquid or aëriform?

You may have some difficulty in understanding this, but I nevertheless assure you that it may be done: they will also return again and again to their former states, as long as the world continues, for there is nothing in nature (not even the elements) that is satisfied with its present condition—all things *are* as they *are* but for a time, anxiously watching the chance of an escape, and of uniting with something else which they take a fancy to; ever restless—ever changeable!

To begin with stone, you only want to be reminded of having often seen papa put a small piece into a wine glass with water, and drop some acid from a bottle, which he keeps very carefully stoppered on

his shelf, and which you have often been cautioned not to touch. Do you remember what happened when the acid was added? There was a hissing noise, and up came from the stone tiny bubbles, pushing their way through the water (apparently pleased to be set free) until they met the air; this is called "efferves- cence," just as the soda water and ginger beer powders phiz, when mixed for drinking. These tiny bubbles contain pure gas, you only see them as bubbles while they hasten through the water, which being liquid and visible fits itself to their shape; gas you cannot see, and what becomes of it when lost to our perception must be told another time, for according to promise I

have yet to make a liquid of this stone. If all that I have been telling you, which papa does in an open wine glass, be done in a close, strong iron vessel, where not a breath of air can get in, and without water, the gas would then be found in a liquid state.

This liquid is a very curious one, for as soon as a small quantity is permitted to escape, it quickly becomes gas, which so rapidly takes away the heat from the fluid remaining in the vessel, that it freezes it like snow.

But this is a very dangerous experiment, especially with glass, for on admitting the air it would fly with a loud crash into many pieces. It is very unsafe to make a large

quantity even in a cast-iron vessel: a dreadful accident happened in Paris, which will, I dare say for some time, prevent its being repeated; the cast-iron vessel burst—cut off both legs of a man, killing him on the spot!

The manner in which I have described this stone being changed into the aëriform, or into the liquid, will not answer for any but limestone; other stones require different treatment, but all can be brought to the same end; and it is the business of the chemist to discover the readiest way of performing this, in order that we may apply the various gifts of God to our present necessities, and secure them also for future generations. The lesson of the chemist

must be learned from Nature; she has worked all these wonderful changes from the beginning of the world, and is still constantly employed in disengaging and re-uniting the ingredients of the globe to form fresh compounds on a much grander scale than man can pretend to! *Her* fire is in the centre of the earth—her water is the raging deep; gases, acids, and salts, all meet or fly apart according to her laws.

I must here mention one of the greatest wonders of the world! one of the vast boilings of nature's central fire, called "the Geysers," in Iceland—yes, in that bitterly cold country, there is a spring which spouts boiling water ninety feet high in the air. The water runs over and covers four

leagues of land, and on cooling, stone is formed of the hardest kind! Before the water was formed, it was doubtless under ground in the state of steam. Thus then, you see, in this one spot, stone produced out of the aëriform into the liquid—out of the liquid into the solid. This particular solid contains a great deal of the material which forms flint. You must not suppose, however, that flint is only produced in this way, there are other sources whence we obtain it, and not the most uninteresting one is that from animals, or perhaps I ought rather to say animalculæ, many of which secrete* flint from the water, just as oysters crabs, and other shell fish appropri

* To separate and appropriate to itself.

ate the lime therefrom. In fact, there is a stone called "Tripoli," which is reduced to powder for polishing metals and marbles, consisting entirely of the cases of very minute animals, which lived in the sea, and took from it the flinty portions necessary for their coverings.

I must, before leaving this portion of my subject, also mention another singular deposit of stone, particularly as it is constantly going on in our domestic circles. Little do people think, while sipping their tea, with the kettle singing cheerfully by the blazing fire, that within that most useful article, a little quarry of stone is in progress. You must have heard complaints of the "fur," and indeed often seen a bit come to the spout,

and perhaps even intrude itself into the teapot! This is a deposit from the boiling water, and is as genuine a stone as that which the Grand Geysers themselves discharge. I have in my collection some pieces from the boiler at Meux's brewery, weighing several pounds: these pieces were formed in the short space of fourteen days; and I am told the incrustation so retards the boilings, that it is necessary to remove it every fortnight: this leads me to mention a remark of your papa's, on the importance of sufficient attention being paid to the chemical qualities of water consumed by different individuals, particularly by those afflicted with a too easy secretion of lime. He knew

a lady whose constitution appropriated the lime in such quantities to the formation of bone, particularly at the joints, that before she died, most of them had become stiff and immovable; had this lady been removed to a spot where the water contained little or no lime, it would in all probability have considerably lessened the evil from which she suffered, and might have been the means of prolonging her life.

Every kind of water, however clear or sparkling it may appear, holds a small quantity of saline or earthy matter in solution; which will, under certain circumstances, separate from the water, and again return to the solid state. When substances are thus held in solution,

they are said to be *chemically* united, which is a far more minute division of matter than can be effected by *mechanical* means; for example, imagine a small fragment of marble or common chalk, ground to the most impalpable powder; take one of the smallest particles so divided to the chemist, and he will again subdivide *that* into two distinct parts (carbonic acid and lime), and in this state we take it either directly in the waters, or indirectly through the medium of such other animals and vegetables as derive their nutriment at once from the produce of the ground. But it is not every constitution that is so pre-disposed to secrete a superabundance of it in the bones, as in the case just named;

on the contrary, some persons need *more* lime to increase the strength of their frame, as in cases of "*ricketty children,*" weak joints, and a deficiency in the teeth, &c. &c.

It is now time to speak of the metals. I will soon prove that they may be altered at pleasure into one or other of the three states mentioned. Let us begin with quicksilver, which you know is used for barometers, and is always fluid in the atmosphere of this country; in some parts of the world, where the cold is very intense, it is solid; by heat it may be completely evaporated, that is, driven off in the aëriform state. This you may do with all other metals. If a careless or ignorant man be employed to cast a bronze without

knowing the exact heat the metal will bear before evaporation begins, he may send a great deal of this expensive material up the chimney, to the great concern and loss of his employer. There are many springs which contain a great deal of iron in solution: they are called "chalybeates," and are very often recommended by doctors to their patients; they have a disagreeable inky taste. Iron combined with other things is frequently given in medicine, both in liquid and powder, as a strengthener; it is altogether the most useful metal we have. That it also exists in an aëriform state seems highly probable: the lumps of stone which fall from the atmosphere, commonly called "thunder-bolts,"

have a great deal of iron in them, often mixed with sulphur. The manner in which these wonderful productions are formed, is of course only conjecture, but one which nevertheless appears highly probable. Since we are certain that minute particles of different matters ascend in the air, we may imagine many of them (having a fancy for each other) meeting, forming a solid, and falling on our earth.

I think enough has been said to convince you that the hardest substances may be changed into liquid or aëriform, and the latter into either of the former, according to different degrees of heat. If there be any substance the chemist still finds unalterable, may we not rather

consider it far more likely that he is ignorant of the proper means of executing it, than that the change itself is an impossibility ?

CHAPTER II.

We now come to the mutual relation of the animal, vegetable and mineral kingdoms. I dare say you know the distinction between these three in a general way, though perhaps in many cases you might be puzzled. The vegetable and mineral are indispensable to the animal existence, but they can flourish independently of us. Let us first look a little into our own construction, and see how far we are dependent upon them. To support life there are two things equally necessary, food and air; the latter is taken in by the act

of breathing through the lungs and skin. I have told you everything in nature is perpetually changing, so therefore are our own bodies; every time we breathe we throw away some portion of our system in the shape of gas and water (the latter you can see by breathing on your slate), and when there is so much gone that we are able to miss it, then we feel what is called hunger.

We may look upon our bodies as wonderful machines, which, being always at work, are constantly wearing away, and unless repaired by proper means, they cease to answer the purpose intended by our Creator. The food we take restores this continual waste, and is obtained, as I said before, from the

animal, vegetable, and mineral kingdoms; in eating the animal we consume the principles of the vegetable on which it fed—and in eating the vegetable, we also partake of the mineral, for there is not a plant growing which has not some portion of *one* mineral at least in its structure, derived from the soil on which it grows. The ingredients of the soil are many, and vary in different places. "According to the rocks," says the geologist, "so we find the soil; as the soil, so the plants; as the plants, so the animals," when left in a state of nature.

Let us now see what the chemist does, not only to prepare our food, but to convert nature's raw materials into clothing, and other necessaries.

If we begin by a slight view of the value of insects, we shall find them (insignificant as they appear) adding considerably to our comforts: the silk-worm for instance, which you yourselves have reared upon lettuce and mulberry leaves: it is from this creeping caterpillar that we get all our silk! Many insects spin a similar material to envelope themselves or their eggs upon trees or bushes, but none produce silk so suitable in length and texture as this worm. Spiders envelope their eggs in cocoons of silk, varying in form and quality in different species, and it was once thought possible to obtain sufficient silk from them; but so many more spiders than silk-worms are necessary to

produce the same quantity of silk, and they being naturally so quarrelsome and ferocious that they devour each other, they were soon pronounced more plague than profit.

Previously to being wound, the cocoons have the loose filaments torn off which the worm threw out as a foundation for its nest; this substance, when carded, forms what is called "spun silk," formerly much used in England for hosiery, but now more particularly for those hats called "gossamer.' After removing this portion of the silk, the remainder is easily wound and dried in the shade; it being necessary to keep the cocoons in warm water while this operation goes on, in order to moisten the gum. The poor

grub, having previously been killed while in its snug little nest by the heat of an oven, or fumes of sulphur, otherwise, on changing into a moth, it would destroy the silk by making a hole large enough to get out, which the creature does by spitting a very corrosive liquid that instantly dissolves the silk. It is in very warm countries that this worm is mostly reared for its silk, and in the East Indies the climate is so favourable to its growth, that four or five crops of cocoons are produced in a season.

There is another little insect, called the cochineal; this is as large as a ladybird, and of the same shape—it is used as a dye. Mexico is the country where they are mostly

produced; the best are fed upon a kind of cactus, and are reared with great care and attention. Women sit beside the plants for hours together, to clear the branches of other insects that would eat them up. When the cochineals have grown to their proper size they are removed from the plants by a blunt knife, and put into pots, in which the poor little creatures are either roasted or scalded to death, in order to furnish us with this carmine for our paints, or crimson for our dyes. I have seen casks full of them at the St. Katherine's Docks, and unless you look very minutely into them, you would think they were merely the seeds of some plant.

To insects of the cochineal kind

we are also indebted for a most useful gum. One little creature in particular (a native of India), affords us a very abundant supply, which is sold in shops under the name of "Shellac."

In the months of November and December they appear, for some time traversing the branches of the tree on which they first came to life, and finally fixing themselves on the extremities of the young branches.

Their legs and feelers by-and-by wither away, and around the insect a sort of liquid appears, which seems to glue it to the branch,—it is the accumulation of this liquid which forms a complete cell for each insect, called gum lacca. These insects generally place themselves so close

together, and are in such numbers, that scarcely one in six can complete its cell; *there* however she ends her life, or rather gives it to her young progeny, who in due time are hatched, run about, and go through the same routine as their parents. *Lac* means milk; the fig trees on which these insects feed, when cut with a knife or otherwise wounded, give out a milky juice which instantly coagulates, or becomes nearly solid, and when dried resembles the gum lac: hence it appears probable that these animals have but little trouble in preparing the sap of the tree for constructing these cells. Shellac is the substance of these cells liquified, strained and formed into thin sheets. This substance

is used for various purposes besides sealing-wax, japanning and varnish. Again,—

> " How doth the little busy bee
>   Employ each shining hour,
> And gather honey all the day
>   From every opening flow'r."

This little insect has always been the emblem of industry. I suppose the action of flying from flower to flower, gives it a busy appearance, otherwise I do not know that it is more industrious than many other insects; as we have observed, the silk-worm spins itself what it considers a safe retreat, while in the grub state. The poor cochineal we seize just before laying its eggs, and another of its species provides us with a most useful gum. The

bees, when they have filled a hive with honey, are either suffocated or removed to another hive, there to re-commence their labours; while we, like thieves, break in and steal their winter's store! You know very well what *honey* is, and how used. You have also carefully examined the honey-comb, as it is called, and remarked upon the beauty and regularity of its cells; but did you ever consider the quantity of wax these little creatures produce? This, I have no doubt, is more valuable to us, than all their honey, sweet as it is. The one we could do without, but not to have any wax would be a serious inconvenience. You have heard of bees swarming, that is, hanging together in clusters,

apparently quite stupified; this they do just before they hive; during that time the honey within them is being converted into a liquid, which after exuding from their bodies, solidifies into thin layers, possessing most of the properties of wax: this substance is afterwards changed into "true wax," by being mixed with a frothy liquid from the bee's mouth, and is then used as a building material, in the formation of cells: after emptying the honey, or liquid sugar, from these cells, the comb, for the sake of obtaining the wax, is usually boiled till thoroughly melted, then strained through a canvass bag into cold water: this is done over and over again, until sufficiently purified, it is then poured

into moulds. It undergoes various other processes—according to the purposes for which it is required; by bleaching it becomes white, fit for candles. It so easily melts and re-solidifies, that we find it a most convenient material for making casts, busts, and medals, not forgetting the pretty dollies, and Madame Tussaud's Exhibition, which pleased you so much last year. There are some plants which produce wax, but although this wax possesses many qualities in common with bees' wax, the chemist finds some difference between them.

There is another insect of the fly species, which is the cause of the "nut-gall," as it is termed; this is an excrescence, varying in size and

shape, which grows upon different kinds of plants and trees, but particularly on the oak, and is useful to us for its astringent quality. I must describe astringent *to you* by taste; it is like very strong tea without sugar or milk, *green* tea more particularly; it possesses a binding or contracting quality, like alum, which is often used to tighten a loose tooth, being so very astringent. Some parts of vegetables contain more of this property than others; the nut-gall does, and for that reason is preferred for purposes where such a quality is needed; as, for instance, in the manufacture of ink, a strong astringent matter must be added to water containing iron in solution,

therefore the manufacturer chooses nut-galls; he could use the bark of the oak, or even fresh shavings of it, but they would not answer so well. I may tell you by the way, that either of these three substances, or others containing astringent matter, will serve to detect iron in any water where we suspect its presence; by adding a little it will of course discolour it in proportion to the quantity of iron it meets with. You may also observe on oak palings, which have iron nails driven into them, a black stream draining from each nail; this is ink, formed by the iron and the astringent matter in the wood, acted upon by the rain, or the night dew. The growing oak, when divided by

a saw, is in like manner stained black from the same cause.

The general history of the nut-gall is this; an insect of the fly kind, is instructed by nature to provide for the safety of her young by lodging her eggs in a woody substance, where they will be defended from all injuries; she for this purpose wounds the leaves or tender branches of a tree, and the lacerated vessels, discharging their contents, soon form swellings about the hole thus made; this excrescence grows into the shape of a little ball, and its external surface becomes dry. Like the other parts of the tree it continues to receive nourishment and grow, even with the little worm within it; on coming from its egg,

the insect finds in the materials of its little chamber (which are as yet very tender), a substance suitable to its appetite and digestion; this it feeds on till the time arrives for it to be transformed into a fly,—then, feeling the warmth of the sun's rays, it gnaws a hole, creeps out and flies away, leaving its old lodging, either on the tree or on the ground, ready for man to use for various purposes.

There is one other insect which deserves to be mentioned, and that is the Spanish fly—which chemists and druggists use for making blisters. Mr. Edwards gave us some one day in a pill-box, to look at; their colours are very handsome—green, gold and brown. They swarm in the forests, on the southern shores

of Europe, feeding on the leaves of the ash and elder trees, and spread around them a strong unpleasant smell. Although some animals that feed upon insects, as the hedgehog, can eat large quantities of them without suffering any injury, their corrosive action on the human skin is so great, that they frequently make the hands of those who are incautious in collecting them, quite sore; when pounded, moistened, spread upon leather, and applied to the skin, they cause a copious effusion of the serous part of the blood, by which many complaints are often relieved or cured.

We have thus noticed six of the insect tribe most useful to man, or rather, whose useful qualities he has

discovered and applied to his benefit; the first for clothing, the second for colouring, the third for gum, fourth, food and wax, the fifth is indispensable in many of our manufactures, and the sixth is equally valuable in medicine!

Let us pause a moment to consider, not only the beneficence of the all-wise Creator, in thus bestowing upon us, through the medium of these little and apparently insignificant insects, such distinct and truly valuable articles, but also let us think how many thousands of persons are gaining a livelihood for themselves and families by preparing and working these precious gifts of God for our markets. How many hands do

they go through, and how many miles do they travel, both by sea and land, before they reach our shop windows! for the living animal, or even what it produces, is rarely ready for use, and even if it were, it requires knowledge for its right application. On looking at a cocoon, who would think of platting its glossy fibres into a dress, or colouring that dress with the cochineal? Who first discovered the nature and uses of gum, of honey and wax? the properties of the nut-gall, the invaluable effects of the Spanish fly? 'Twas man, the mighty mind of man, himself an animal, however elevated above all others of his class. But is there not also a difference between one man and another?

Yes, a great, an immense difference, even "as one star differeth from another in glory"! Some plod through this life, partaking plentifully of the provisions rendered thus serviceable to them by the brain of their fellow-men, never thinking of the *why* or the *wherefore:* they buy their food, pay their cook, order their dress, and sleep upon downy beds, little dreaming how systematically all nature is combined, to secure to them these comforts. But some there are, few indeed by comparison, whose delight is in the book of nature, seeking her laws, and applying them to agriculture, arts, and manufactures. To them it is that we are indebted, frequently even for our lives!—call them che-

mists, philosophers, wise men, or any thing you please, *they* are the enviable beings to whom our thanks are due; enviable, because by the cultivation of their minds they have attained an insight into nature's wonders, and the use of her agencies unknown to others. Sufficiently are they repaid, by the pleasure they derive from such knowledge, and the respect that is paid to them in society for imparting it.

The animals of which I have been speaking, are not by any means the smallest of the creation; we are much indebted to minute creatures termed "animalculæ," generally too small to be seen without a magnifying glass. The very insignificance of their proportions raises our astonishment,

when we consider that they exist in numbers so vast as to build up large tracts of country from the depths of the ocean, with a perseverance that quite equals the workings of the bee, adding incomparably more to the mass of materials which compose the crust of the globe than the bones of elephants and whales. Corallines, of which I have many specimens, constitute a considerable portion of the rocky islands in various seas. If you examine the large branching specimen called "Madrepore," you will find it full of little cells, each of which was once inhabited by a living animal, which, like other shell fish, formed its dwelling out of a material collected from the sea. While alive, they are constantly stretching them-

selves out of their little holes, with open mouths, or rather open stomachs, to procure food; and when dead, their cells, which are similar to the coralline you see, still adhere to each other, and the interstices being gradually filled up with sand and broken pieces of coral and shell washed in by the sea, a mass of rock is at length formed; younger animals spread out again at its edge, in their turn die, and add to this mass of rock, which in time thus becomes a large island, and when first it rises to the level of the water, is too often the cause of shipwrecks.

Madrepores, however, are giants compared with many other species we term animalculæ. The air we breathe is charged with the rudiments of life

floating continually amidst the atoms of dust we see twinkling in a sunbeam, and ever ready to start into life as soon as they meet with a spot adapted to their development. It is a well known fact that animalculæ of definite characters appear in infusions of vegetable and animal matter, even when prepared with distilled water. The case is the same with respect to vegetation; various fungi start into life without any apparent cause, when in fact millions of seeds are continually and imperceptibly floating in the air, ready to vegetate on meeting with a suitable situation.

From the crowded condition of the waters of the ancient world (which is manifested by the multitude of fossil microscopic remains), it is equally

evident that nature has always been thus prolific. Thousands of microscopic shells may be extracted from a small piece of chalk, by rubbing it with a brush in water, and to give you an idea of their minuteness, numbers of them can pass through blotting paper when used as a filterer. On placing living specimens of animalculæ in a microscope, the smallest drop of water, pressed between two glasses, allows them sufficient space to swim about, without the least interruption to their gambols.

But let us pass on from these minute tribes, to a class larger in the scale of animal existence. You know the difference between "bipeds" and "quadrupeds;" also, that animals feeding on flesh are called

"carnivora," and others eating grains, vegetables, &c. "graminivora." Philosophers can tell, by the shape of the jaw and teeth, to which class any animal belongs, and on what it feeds: a little reflection will teach you this. If you ever noticed the teeth of the lions and tigers at the Zoological Gardens, you will remember that they have cutting teeth in front, sharp fangs at the sides, and bruising or crushing teeth at the back; all are covered with a thick enamel; this is evidently an apparatus for tearing and cutting flesh, or for cracking bones, but is not suited for grinding the stalks and seeds of vegetables. In animals which are destined to live on these productions, the sharp fangs of the teeth

are wanting, the enamel is not all placed on the top of the teeth, as in the carnivora, but is arranged in deep upright layers, alternating with bony matter, which causes a rough surface, as in the elephant's tooth.

It is not however alone by the teeth that we can discover these distinctions, so admirably is every part of the animal frame adapted by its Creator to the functions it is destined to perform. If the creature has to carry off its prey in its mouth, it is provided with extra strong muscles in the neck, and paws capable of clutching; not a hoof like a cow, or a horse. In birds, those that perch, and scratch up the ground, have claws to do so, while in others that swim, the foot is webbed, ready to strike

against the water, like an oar, or a paddle.

Thus has the Almighty Creator varied the formation of his different creatures, according to the element and climate, and to every possible variety of food, and mode of existence.

The study of geology shews us that many different kinds of animals formerly existed on the earth, which are now no longer met with alive; this may be attributed to several causes, which we will consider another time; but since man has had "dominion over the fish of the sea, the beasts of the field, and the fowls of the air," as the Bible informs us, of course *he* has done something towards extirpating certain races

of animals, which were either obnoxious to him, or so useful as to induce him to keep up a perpetual hunt, and thus improvidently diminish, or altogether annihilate them. As an instance of the possibility of the former, I need only quote a portion of our English history, which says, that Edgar changed the tribute imposed upon the Welsh, by Athelstone, into an annual tribute of 300 wolves' heads. Wolves at that time being extremely numerous in England, the tribute caused such diligence in hunting them, that they soon disappeared in this country.

Again, there is such immense destruction occasioned by man, amongst the animals which supply fur, that it appears almost certain that the

trade must henceforward decline, as no other islands of great magnitude remain to be explored, and the animals are gradually decreasing, from the continual pursuit and indiscriminate slaughter practised by the hunters, or by the appropriation to the use of man of those forests and rivers that once afforded food and protection to those animals.

Although it seems the intention of Providence that the lower orders of animals should thus be subservient to the comfort, convenience, and sustenance of man, remember his right of dominion extends no further; it ought to be his great consideration to inflict that death, which is indispensable to his own life and enjoyment, with the least

possible pain, as well as in the most expeditious manner; and never unnecessarily harm anything. It is not uncommon to see young folks torturing poor dumb creatures in various ways, but hard and wicked must be the heart of those who do so merely for the pleasure of witnessing their struggles; nor are children alone guilty of this inhumanity, for it has been found necessary, in this great city, to form a "Society for the Prevention of Cruelty to Animals." This tells a disgraceful tale!

CHAPTER III.

Proceeding to particulars more within our immediate observation, let us consider an animal with which you are well acquainted, and see what use we have been taught to make of its different parts. Let it be the cow. What does she afford us in return for our care? Flesh, bones, skin, hair, hoofs, horns and milk. These, however different they may appear, are all composed of nearly the same elements. As I have only once before alluded to the word "elements," it may be better here to mention, that they are the principles

or ingredients, if I may so term them, of which all bodies in the world are composed; they are comparatively few in number, and are in themselves exempted from change or decay; it is by their different combinations and proportions that we have the extensive variety of objects that abound in nature; for instance, in grass, there are all the elements necessary to form the flesh, bones, skin, &c. of the cow, and other herbivorous* animals, with the assistance of air, and perhaps water. The grass drew from the earth those elements which nourish most vegetables, notwithstanding the variety among them with respect to hardness, softness, elasticity, taste,

* "Herbivorous" means feeding on herbs or vegetables.

odour, and medicinal qualities, assisted by water, air, and the light and heat of the sun. In the lettuce and mulberry leaves the silkworm finds the elements of silk, and in the fig tree are the elements of gum-lacca, ready for the little insect I told you of, to convert to its own and our use.

The flesh of the cow, like that of the ox, is sold as beef—and in eating that, we consume the vegetable principles or elements which served for its formation; thus then you see the animal kingdom grows out of the vegetable, and the vegetable out of the mineral kingdom; they are, as it were, indispensable to each other's formation and increase; not but that the two latter

might flourish, as the Bible tells us *they did*, before animal matter was introduced; we may consequently look upon the animal, as a higher kind of vegetable organization, or rather a still grander application of the original elements.

Bones, which you know to be the frame-work on which the flesh and all the soft parts of the body rest, differ in form, number, and position according to the requirements of each class of animals.

The bones of men and quadrupeds are not exactly of the same nature as the soft flexible bones of fishes, or the horny coverings of insects, the limy shells of the lobster, crab, oyster or coral, but these are all the skeleton or support of the

fleshy portion of those different animals; and the principal difference I believe to be more in the proportions of the elements, than the actual absence of any one. Ivory and teeth are composed of nearly the same substances as bone; so are the nails and the hoofs and horns of animals; these, as they readily part with their gelatine, are selected for the purpose of making glue; glue however is likewise found in the tendons of the skin, and in bone, (I have a piece prepared from shin of beef, by Mr. Aiken,) the parings of hides, scraps of skins from the furriers, and hoofs and ears of horses, oxen, calves and sheep; these animal substances, when freed from the grease which accompanies them, are well boiled, and the water

evaporated until it becomes a solid tremulous mass as it cools; then by still further drying in the open air, on a net work erected for the purpose, we obtain the brittle, transparent substance we call "glue."

There is another fine species of glue, called "isinglass;" it is the produce of a certain fish common in the Russian rivers; it may also be made of the air-bladder and sounds of cod, but fresh water fish afford the best. "Size" is made from the skins of rabbits, hares and cats—and when required for delicate workmanship, it is obtained from the skins of eels, vellum,* parchment and white leather.

* Vellum is made of a portion of the skin of the calf; parchment is a similar preparation of the skin of sheep.

When you think of the many demands for leather, not only for boots and shoes, and a piece for mamma's plate basket, but for saddlers, bookbinders, coach and trunk makers, and upholsterers, you will not be surprised to hear that millions of skins of oxen, horses and sheep, are annually in this country turned into leather: the thinner and softer kinds of the deer, lamb, goat, kid and dog, are for lighter purposes, equally in request. When you see a butcher's cart full of skins, you may guess he is going to take them to a tan pit—which is a large hole in the ground, where they are put to soak in oak bark and water. Thick skins require some months before they sufficiently imbibe this mixture; and unless it

completely enters every pore, the skin is liable to putrify, or become rotten, and let in wet. They are first, however, well washed and soaked in lime water, and have all the hair scraped off; the fleshy surface of the skin is also well pared, so that there may be nothing to prevent the "tannin," as it is called, from getting well into the skin, and doing its work properly.

There are various machines used for washing, splitting, softening and finishing leather, and for those skins that are to be dyed, either alum or sumach is used instead of oak bark, which makes them beautifully white and clear, while those intended to be brown, are tanned with oak bark only.

What we call the skin of an animal, may be divided into three layers or skins; the outer one, being unprovided with blood vessels and nerves, is consequently insensible, but is pierced by innumerable minute pores, which are the mouths of the perspiration vessels; it is thicker in the palms of the hands, and soles of the feet, than in any other part of the body. Below the outer skin is a thin one, which assuming different hues in different nations gives rise to the variety of colour in the human race. Immediately below this, is the "true skin," as it is called, which is extremely sensitive, being so thickly studded with minute blood vessels, and branches of nerves, that the smallest pointed

needle cannot prick it without touching some of them. This wonderful intention of sensibility is absolutely necessary for our safety, it is always in proportion to the capabilities of the animal, and is therefore greatest in mankind.

The hair of animals is as much in request, as any other part of the body; the more beautiful and rare varieties being reserved for ornament, while the coarser sorts, such as horse and cow hair, wool, pig's bristles, &c. are more serviceable for the common purposes of life. Hair grows somewhat in the manner of a vegetable production, it is fixed by a root into the inner skin, whence by numerous minute vessels or roots it draws nourishment, and continually

increases in length; the curling propensities of wool render spinning and weaving it into cloth difficult operations; the fibres must be covered with oil to make it work more easily, but after the piece of cloth is finished, this oil is to be removed, as it would grease every thing it touched, it would besides have an unpleasant smell, and also prevent its taking the colour intended to be given by the dyer; it is therefore carried to a mill, which by turning round causes a sort of pestle to beat the cloth, which is laid in soapy water, until it is not only cleansed from the oil, but the fibres are so matted together that it becomes thicker and warmer clothing, and may be cut without danger of ravel-

ling. Some flannels are treated in this way, and are called "milled." Wool is mixed with fur, and these are felted together in a similar manner for hats, the last coating only being of beaver. As the blood does not circulate in them, neither hair, wool, nor feathers possess warmth or feeling like our flesh, but as *clothing* they keep the warmth of our bodies from wasting. The quills of the porcupine are no other than a very coarse sort of hair, and the quill of a feather is similar; some varieties of the large owl have perfect hair about their eyes and beak, while all the rest of their bodies is covered with perfect feathers, we may therefore consider them as of the same nature; the hair of animals is employed for

a vast variety of purposes, from the dignified court plume, to piggy's bristles, which are so often in the housemaid's hands, in the shape of a broom: these by the by are obtained from the wild boar of Germany, or are imported from Russia. The Russians do not kill their pigs so young as we do, because they can sell the hair of the full grown animals to greater advantage, but at the same age the English bristles fetch the highest price.

Milk is a liquid bestowed by the Creator, upon the cow and all animals belonging to the highest class, called "mammalia,"* for the purpose of nourishing their young.

* The word "mammalia," owes its origin to the word mamma, which is the Latin word for "breast."

White as it is, it contains all the elements identical in composition with the blood of the animal, and is capable of being made into whey, butter and cheese, with all of which you are well acquainted, that is, as far as regards taste; of their other qualities you have yet much to learn.

I have now, though somewhat slightly, touched upon a few of the uses to which we have applied the poor cow. We might have noticed how useful her hair is to the builder, to mix with his mortar, for plastering walls, and also have mentioned the nourishment her bones and those of other animals afford to our land; ship loads come to England from the continent, for this very

purpose, besides all we can collect in our own country; but to enter too deeply into these things at present, would only puzzle you, and swell this little book into a big one. I have yet to call your attention to substances met with in the vegetable world, which are quite as useful for food, clothing and medicine, as any of the animal productions already mentioned; there we also find salts, acids, oils and gums, fibres for cloth, colouring matter for the dyes, food, besides soothing balms for the most agonizing bodily pains; but none of these are ready to our hand. Here again must we call forth the reflective powers of the mind, or the flax would grow in vain, the cotton-pod be but sport for the wind, and the

useful, nourishing, and healing qualities of many a plant would be for ever locked up within itself. How grateful ought we to be for the intellect bestowed upon our race by our Heavenly Father! My dear children, let not so precious a gift be kept idle, like the servant's unprofitable talent we read of in the New Testament; but bring it forth and turn it to good account: remember it is that intellect which not only makes things minister to our necessities, comforts and luxuries, but brings us constantly in communion with our Creator; such intercourse elevates the mind, improves the character, and thereby renders us more beloved, more reasonable, and consequently happier beings.

CHAPTER IV.

Before entering into any remarks respecting the application of plants to the use of man, I ought to give you a general idea of their structure and manner of receiving nourishment to support life,—for *life* they have, though not in every respect like our own; still they as certainly breathe, eat, drink, (and many sleep,) die and decay, as we do ourselves. There is quite as much variety in the vegetable, as in the animal world, therefore of course my remarks must here again be general; we find, however (as I said

in alluding to animals), that each species is best adapted to the purpose for which it is destined by its Creator, from the mildew on an old cheese to the stately cedar of Lebanon.

Although, as a general rule, plants have roots, stems, leaves, &c., this rule is not altogether without exception ; in some, one or other may be altogether wanting, or so altered in its nature as scarcely to be recognized. Plants not only absorb nourishment from the ground, but also take in gases at their leaves from the atmosphere. The nourishment which they absorb by their roots must be fluid, and this having previously imbibed all matters within reach, the plant, as if by instinct, selects those which it requires, and

introduces them into a little mouth at the end of each rootlet (which is large or small according to the food required); this is forced up, in the form of sap, into every minute vessel, as the blood passes through the veins in our own system, and its properties are altered on reaching the pores at the surface, like our blood on its coming in contact with the air in the lungs: it then returns by a different road, depositing its nourishing particles, and ejecting the refuse, without in the slightest degree interfering with the absorption still going on.

The sap passes up through the woody part of the plant, and returns near the bark: by looking through a microscope at a living plant all this

is distinctly observable, and a beautiful sight it is.

Mineral substances are often detected in plants, and it is by nature's wonderful dissolving powers that these hard materials are rendered fit to enter into such delicate structures. Iron is very frequently found, and some plants, particularly the grasses, contain a great deal of the material which forms flint; we have a trace of iron in our blood, and this is doubtless introduced (if not directly from the plant itself) from eating an animal which previously fed upon the vegetable containing it.

A great deal more might be said on this interesting subject, but you are yet scarcely forward enough to understand me; I will therefore pass

on to some of the uses we make of this extensive and valuable portion of the creation.

For food, we choose either the root, stalk, leaves, fruit or seed of a plant, according to its taste, medicinal or digestive qualities, but the seeds are pronounced to be the most nourishing; this you will be glad to hear, for you are fond of eating peas, beans, and bread, the latter is made from the seeds of wheat. Seeds retain the power of growing for an immense time, perhaps for ever, if kept dry and uninjured by insects. I have heard of wheat being deposited with mummies for countless ages, and afterwards on being sown, growing as well as that of the last season.

Although the natural mode of

rearing plants is from seeds, cuttings from the parent stem are frequently preferred for the sake of expedition; this is the case with the sugar cane. As you are fond of sweet things I must tell you something about that. It grows most abundantly in the West Indies, and if the soil contains plenty of the food it likes, it sometimes attains the height of twenty feet. People are now growing wiser about the soil they choose for their plants, taking care to place within reach of the roots such food as is most nourishing and fit for their particular growth; they are consequently rewarded with a finer crop of corn, sugar, cotton, or potatoes, as the case may be: after growing a field of wheat, for instance, may we not rea-

sonably suppose that it has used most of the nourishment the ground contained for its increase; and that a second crop of wheat upon the same spot would get but a scanty fare, and perhaps a third would not grow at all? Upon considering these things, and discovering what each individual plant requires, the chemist has at length found different restoratives to re-nourish the land according to the vegetable proposed to be grown upon it; these restoratives have received the name of "manures."

But to return to the sugar canes. You have seen drawings of them, if not the real thing, and know how nearly they resemble canes or sticks; these, when fully ripe, are cut down close to the ground, and being di-

vided into convenient lengths, are tied up in bundles, and taken to a crushing mill or press, to have the juice squeezed out. This juice must immediately be boiled, to prevent its turning acid or sour; then, by cooling it in shallow trays, the more fluid portion, which is principally water, evaporates, and the remaining moisture (which is a coarse sort of treacle) is allowed to drain from it. It is then put into barrels and shipped for market in the state of crude moist sugar, such as we use to sweeten tarts, or to be purified by the refiners ready for use at the tea-table. I dare say you think it very odd that sweet juice like this should ever turn acid: it would never do so while it remained confined in the cane, any more than

milk would turn sour before taken from the cow, but expose either to the air, and the absorption of oxygen, the cause of acidity in most things, produces the change.

I may here just mention that the process of manufacturing *loaf* sugar has of late years undergone considerable change, owing to the introduction of animal charcoal, which is now used instead of bullock's blood.

Preparing the animal charcoal for this purpose appears to be an important and somewhat extensive business and affords us another instance of the usefulness of bones.

The bones employed, which are principally those of oxen and sheep, are collected in vast quantities, and subjected to a considerable heat in

close vessels, so as to prevent the escape of the carbon they contain, which, having a strong affinity for oxygen, would if left free fly off in the state of carbonic acid gas.

After being allowed to cool, still in confinement, they are taken out and reduced to powder, in which state they are forwarded to the different sugar refiners for use.

This powder is added to the raw moist sugar, with a certain quantity of lime and water, and on the whole being boiled together, the charcoal rises to the surface, bringing all the impurities of the sugar with it, and is easily removed with a skimmer; when sufficiently boiled and skimmed, the syrup is placed in coolers, and violently agitated, in order to break

the crystals whilst forming, which would if undisturbed become as large as those of sugar candy.

The sugar being now white, and small-grained, is put into unglazed earthenware pans of a conical shape, which are set with their broad end upwards, and the remaining liquid (molasses) soon runs down, and escapes, partly by filtering through the pores of the vessel, but principally through a small hole at the pointed end, leaving the sugar much whitened by the separation, which is further assisted, if requisite, by additional moisture applied to the surface of the sugar, which slowly percolates the crystalline mass, and washes it from all remains of colouring matter. The loaves are in due time turned

point upwards, and thoroughly dried in a heated chamber.

Sugar (also tallow) being now boiled in water baths, instead of coppers placed unprotected upon the fires, is another great improvement, and a reason for its being sold cheaper, as fewer men are requisite to watch the boilings, which were formerly attended with so much danger that the Fire Offices even refused to insure the buildings.

The fluids contained in vegetables are of two kinds, first the sap, which acts the part of blood in plants, and secondly those which are peculiar to certain species, such for example as resins, gums, and oils, besides the sweet juice of the sugar cane already mentioned, and which likewise exist,

though in smaller quantities, in a great many other vegetables. Although these substances are very unlike each other, they are actually found to be composed of the same elements, only united in different ways and proportions. Thus does nature, from watery sap and atmospheric air, form gum, sugar, starch, liguin, resins, oils, acids, alkalies, &c., by merely varying the relative proportions of the three simple elements oxygen, hydrogen and carbon; others are seldom and sparingly employed.

Resin is abundantly produced in many trees, particularly those of the fir kind: after that wood (commonly called "deal") is sawed, and even painted, you may frequently see the resin ooze out in large transparent

beads, which adhere to the surface. Resins look very like gums, but may be easily distinguished from them by the fact that they dissolve only in oil or spirits, and will also melt by heat, whereas gum will soften or dissolve in water only, and burns to a cinder. Gum arabic may be taken as a specimen of pure gum; cherry tree gum, and those from all stone fruit trees, do not readily dissolve in cold water, but in other respects their properties resemble those of gum arabic.

Starch, which is also found in considerable quantities in plants, is very similar in many of its properties to gum, and is composed of the same elements; it forms an important part of all the seeds and roots consumed

by man, being highly nutritious. The common process for obtaining the starch from wheat (which is that used by laundresses) consists in steeping the grain in water till it becomes soft; it is then put into coarse linen bags, which are pressed in vats of water: a milky juice exudes, and the starch falls to the bottom of the vat; it is then collected, washed, and dried in a moderate heat, during which it splits into the well-known columnar fragments: it is generally rendered slightly blue by a little smalt. A remarkable characteristic property of starch is that of forming a blue compound with iodine: this may be obtained by adding an aqueous solution of iodine to a similar solution of starch. There is a common practice amongst

laundresses, of stirring the starch while hot with a tallow candle; those who are a little more particular use wax, but either of these greasy materials must, on the application of a heated iron, turn proportionally brown, as all burnt fat does, and thereby discolour the linen.

Oils are formed in all parts of plants, but most abundantly in the seeds and fruits, some seeds containing nearly half their weight of oil.

Under one general term is included all those oleaginous substances which are usually denominated fatty and oily, whether derived from the animal, vegetable or mineral kingdoms. They differ in their appearance and external character in an ordinary atmosphere; some being solid, as the

suet of various animals, particularly that of the ox ; while others are fluid at the same degree of heat as most of the oils ; others again are not only fluid, but exceedingly volatile, such as turpentine, &c.; each however may be changed into the solid and liquid state at certain variations of temperature. The odour of most strong-scented plants depends on the presence of these oils, and their extreme volatility, as otto of roses and many other essential oils, whose fragrance induces us to employ them as perfumes.

Whales, and all cetaceous or warm-blooded fishes, contain a large quantity of olifiant matter, which in consequence of their living in the water (an element always colder than

the atmosphere above it) becomes, in our temperature, a most convenient fluid for many purposes.

Before the general introduction of gas, for lighting the streets, oil was used, and it was found that the only oil which would continue fluid during the frosty weather, was that obtained from the *North Sea* whales, where the water is exceedingly cold, containing large masses of ice: *that* oil remained fluid, when others became congealed.

Crude fat or oil is mechanically composed of two substances, one heavier than the other, so that when oil is allowed to remain undisturbed for some weeks, or months, the upper part is found to be much more fluid, than the lower. In order to procure

sperm oil, the fat of the spermaceti whale is put into woollen bags, and the oil oozing through them is thus separated from the more solid portion which is called "spermaceti."

Common tallow, though it appears to be a very uniform substance in the solid state, may also be separated into two distinct materials; the more solid, under the name of "stearine," has been employed in the manufacture of candles. Cocoa-nut oil, which during summer, even in our climate, is perfectly fluid, and capable of being burnt in a lamp, becomes thick at a somewhat lower temperature, and is filled with white solid particles; these being separated by pressure from the fluid portion, form a substance, which is also made into candles.

Vegetable substances are as extensively applied in the arts and manufactures, as the animal or the mineral. For some purposes the whole plant is required, for others the root only, or the leaves, the wood, stem, flower, seeds, shoots or juices. For dyeing they are particularly useful ;* mineral substances are likewise employed very numerously to impart colour, and are also used to fix or to brighten those given by vegetables. You have only to look around, even in this

* Turmeric and madder are very largely employed by dyers—the former is with great care and talent rendered tolerably permanent, whilst madder is invaluable from its enduring beyond almost every other dye, especially on cotton.

Hoyle's lilac and purple prints, which are all dyed with madder, are largely sold in the shops, and much esteemed.

small room, to see the various objects for which we are more particularly indebted to the vegetable world. The different woods for our furniture, the cane seats of your little chairs, the young shoots of the willow for baskets; it would be endless to enumerate them. Cotton and linen are *too* important however to pass by, without a few remarks, particularly as I can shew you a pod of cotton, with the seeds securely buried in its centre. It is a long and troublesome operation to separate these seeds from the cotton by hand, for the fibres of the cotton cling to them so tightly; but in the greater part of India, where the cotton tree grows, the use of machinery for this purpose is not applied, and there it

is consequently picked by hand. The cotton tree will grow in most situations and soils, provided the climate be warm enough: it is cultivated with very little trouble or expense, and is sown and reaped like corn; the cotton harvest in hot climates occurs twice, in cooler countries once, a year.

It bears a large yellow flower with a purple centre, which produces the pod—this, when ripe, bursts and exhibits a beautiful fleecy cotton. There are many varieties of the plant, growing to various heights, but the cotton is not always white, there is a yellowish brown, the material of which nankeen is made; it may therefore be presumed that it grows flourishingly in China, whence nan-

keen cloth is obtained; but our vast cotton manufactories, the most renowned in the world, are almost entirely supplied from the United States of America.

Vegetable or woody fibres exist in almost all plants, constituting the greatest part of the stem, bark and branches of trees, and may be traced in the most delicate leaves, flowers and succulent plants; it forms a substance of considerable use in the arts and manufactures, furnishing thread, cloth, cordage, &c.: for these purposes the fibrous parts of the hemp and flax are employed amongst us, but different vegetables are used in different countries for the same purpose. By steeping these plants in water the green soft parts decay, and

at last nothing is left but the woody fibre, as completely devoid of other matter as the beautiful skeleton leaves we sometimes pick up in autumn, whose green soft parts are by constant wet upon the ground rotted away, or have been eaten by insects.

Hemp is now cultivated in many countries, but the grand market for it as an article of commerce is Russia, where it is grown in immense quantities, and of the best quality; it is the woody fibre of the stalk we use, which is a white tough substance, composed of an infinite number of very fine threads or fibres, insoluble in water, and not at all altered by keeping in dry air; it burns like wood with a bright flame.

Flax for cambrics and fine lawns requires a richer soil—it cannot be too rich, and great care and attention must be paid to it; the important property of this flax is to be fine and long: pulling it up green prevents that coarse hardness which flax acquires when left to ripen, and preserves its fine silky appearance.

I told you that in the vegetable world we might also find soothing balms for the most agonizing bodily pains; this particularly alludes to opium. It seems grievous that in discovering a blessing so valuable, we should at the same time be opening the door to what may with equal truth be termed a curse! but this may be said of all extreme indulgence in useful things,—it is not because the

Almighty has spread before us a bountiful table, that we should eat and drink without reason or reserve: still there are greedy wicked persons who do so, particularly in the use of opium, and severely are they punished, for they not only lose their senses for the time, but very frequently for ever.

This powerful drug is the gum or juice of the poppy; a plant of which numerous varieties are well known in England; but opium is chiefly prepared in India, Turkey and Persia, from the white poppy, which is carefully cultivated for that purpose.* From incisions made in

* The red poppy is cultivated in some countries, but this is more particularly reared for the sake of its oil, so useful to the artist to mix with his colours.

the capsule of the flower a milky juice exudes, which thickens on exposure to the air ; this is afterwards carefully scraped off with a shell or blunt knife, and is packed up with leaves between each lump to prevent their sticking together, and sent to different markets. It is also prepared as a medicine, and its lulling effect upon the nerves renders it peculiarly valuable.

It is comparatively a *small* quantity however which is required for this purpose : it is much more extensively used in India, Turkey, Persia and China, for smoking and chewing, and the people use it to such an excess that it causes in some intoxication and its attendant miseries, in others convulsions, madness and death !

I mentioned the extraordinary tenacity of the vital principle in seeds when referring to the wheat deposited with mummies, 3000 years ago, but the term of vegetable existence, from the period of its first sprouting till the death of a plant, is extremely various. Some plants probably terminate their vital career diurnally, others merely live through a few summer months; and the larger varieties of the vegetable kingdom, that properly belong to the forest, may be said in many instances to outlive every other species of organnized existence, such as the yew tree, the mahogany, and above all the cedar and oak; we have examples of the latter in this kingdom, which are known to have existed during the

time of the Saxon monarchs, and in all probability determined the boundary lines of their respective domains.

I told you, in the course of my remarks upon animals, how, by a knowledge of the different bones, even from the shape of a single tooth, the philosopher can tell to which class of animals such remains belong (page 46); so likewise can the well-informed botanist determine to the greatest certainty the form and character of a vegetable, although but the faintest vestige perhaps remains to unfold the apparent mystery, and even though that vestige be changed from the delicate vegetable into the hardest mineral. Upon examining a cross section of the trunk of one

of those trees, for instance, which increase in size by the yearly deposition of a single layer between the wood and bark, we may determine the age of the tree, and also from the disturbed state of those rings in certain parts, we may pronounce the exact year in which each branch first sprung from the parent stem ; and again, the relative thickness of each ring, depending more or less upon the flourishing state of the plant during the year in which it was formed, enables us to calculate, with some degree of probability, the nature of the season in which each of these separate rings were produced, whether hot or cold, wet or dry. These effects are obvious to our senses ; but every shower that falls, every change of temperature

that occurs, and every wind that blows, leaves on the vegetable world the traces of its passage; slight indeed, and imperceptible to us, but not the less permanently recorded in the depths of those woody fabrics.

Every true lover of nature looks on the vegetable world as a source of contemplation, whence he may at all times derive real pleasure and profit. When do we ever walk over the verdant hills, or in the shady groves, without experiencing heartfelt delight? They lead us on to the contemplation of the setting sun, or starry firmament, with an additional feeling of devotion and reverence towards their Divine Author! A contemplation of the works of God must assuredly call forth all the best feel-

ings of the mind! Seek therefore in the varied landscape, amidst its moss-clad ivy-mantled rocks, meandering weedy rivulets, or mighty billows of the ocean, and you will find, according to the words of Shakspere,

> "Tongues in trees, books in running brooks,
> Sermons in stones, and good in everything."

CHAPTER V.

In passing from the vegetable to the mineral kingdoms, I cannot perhaps do better than follow Dame Nature in one of her own tracks, which will conduct us to the mineral formation, *coal*; because before that was the black shining substance we burn, it consisted of the trees, plants and mosses of ancient forests; ancient indeed beyond all our ideas of time,—long, long ago! You know we now find it underground at various depths from the surface; in some places quite near the feet, in others perhaps a quarter of a mile deep: but

so important is it to our manufactures and general comfort, that it is even worth while to dig it out from that distance.

Coal is found more or less in most countries; it varies a little in composition, according to the circumstances under which it was formed, or the description of trees or vegetables of which it consists, some containing much more bituminous matter than others; but altogether we may look upon coal as vegetable matter changed into mineral by a peculiar kind of putrifaction which it underwent when buried beneath the surface of water in the absence of air! But how came it in such a position? This the geologist must answer. He knows that the land, like everything

else in nature, is always undergoing change. Many mountains are formed by the accumulation of matter ejected from volcanoes: earthquakes cause immense separations, the waves dashing on the sea coast continually wear it away; islands have been known to disappear beneath the water, while others again are seen newly expanding on the mighty deep! these and various other causes tend to alter the position of land, taking with it its animals, vegetables and minerals. The forests or thickets, afterwards converted into coal, contained few sorts of plants now growing on the earth; the extinct species peculiar to that era were of gigantic size, those we now have, that somewhat resemble them, are comparatively of

small and lowly forms. Coal occurs in different thicknesses, from a hair's breadth to six or eight feet, each stratum being separated from the other by various earths, frequently lime or sandstone and iron ore, bits of which we occasionally meet with in our coal-scuttles; it also contains sulphur in greater or less quantity, which on being burned is disengaged from the coal in the state of gas, causing the disagreeable sulphurous smell that frequently comes from Papa's stove.

It is in the different materials which divide the layers of coal that we find impressions of the ancient plants which are now become coal; these divisions or beds being generally of a light colour, admirably display the dark image of different sorts of vege-

tation, and enable the botanist to discover their varieties. Shells, principally of species belonging to fresh water, and the remains of animals, are likewise met with abundantly: we will notice some specimens the next time we go to the Museum.

Of the important uses of coal, in administering to the supply of our daily wants, you scarcely need to be reminded. Our fire now burns with fuel, our streets are shining with the light of gas, derived from the coal that has been buried for countless ages in the deep and dark recesses of the earth. We prepare our food, maintain our forges and furnaces, and heat our steam-engines, with the remains of plants of ancient forms and extinct species, which were

swept from the face of nature thousands of years before the human race appeared upon it!

While speaking of coal, I must not forget to mention *jet*, the black glassy-looking substance of which my shawl pins are made. Jet is composed of the same ingredients as common coal, only mixed in different proportions; it occurs in Scotland, at Whitby in Yorkshire, in Bavaria, and in France near the Pyrenees, where more than a thousand men, it is said, are constantly employed in making it into ornaments of dress, drinking vessels and rosaries.

Both animal and vegetable remains vary materially in appearance and preservation, according to their composition, and the local circumstances

under which they become imbedded; some are turned into a common-looking stone, others exhibit beautiful spars of different colours, while others again are wholly or in part changed into or incrusted with pyrites, a bright yellow metallic substance, which is a combination of sulphur and iron. The process may be thus described: as soon as death takes place, the air and moisture in most cases exert their power without opposition on animal and vegetable substances, and set the elementary atoms free; the remaining portion of these elements meeting with others suitable to form fresh substances, a mutual action takes place, by which solid particles are produced, and occupy the space left vacant by the original matter, which

had been removed in a state of gas or moisture. The beautiful varieties of once living forms that are met with thus changed, draw forth an exclamation of wonder from the most common observer, and afford the scientific mind a perpetual source of pleasing and intellectual study.

I have already told you of springs whose waters contribute to produce hard stones; this is in consequence of their containing quantities of stony matter, such as flint, chalk, or lime, in particles so minute and transparent that the liquid is perfectly clear and sparkling. In some places the water contains so much lime, that on its spouting out upon leaves, stones, branches, or other objects, they become immediately

coated with this stony material, and have the appearance of real petrifactions. I have a bird's nest with eggs in it, that was placed under one of those springs in Derbyshire; and a piece of incrustation that was formed round a rush in a warm lake near Rome. Many of the buildings both of ancient and modern Italy are built of this "Travertine," as it is called.

There are many caverns celebrated for the variety and beauty of their sparry productions, the sides and roofs being covered with immense incrustations, which are formed by water (containing lime and other matters in solution) constantly dripping through the rocks and solidifying, some on the ground, in the shape of little hills ("Stalagmites"), and others

from the roof like icicles ("Stalactites"), which on meeting form columns; these are again filled in by others, until the whole cavern becomes one solid mass, and may be compared to a quarry of marble.

Notwithstanding the different materials of which our earth's surface appears to be composed, it is found by philosophers to consist chiefly of metals, united in different proportions with oxygen (which you remember I told you is part of the air we breathe); those are again found combined with two other substances quite different from metals, the one carbon (which is the chief portion of charcoal), the other silicium (chief portion of flint); there is one more, which sometimes takes the place of

part of the oxygen, it is called sulphur, or commonly brimstone; and last, though not least, common salt. In these we have almost every substance which exists in a solid form upon our globe in any considerable mass; other compounds, exceedingly numerous, are met with, but in small scattered quantities: the mould in which our plants flourish is formed from decomposed rocks, certain metals, principally iron, and decayed animal and vegetable substances.

With the exception of gold, silver, platinum, and copper, metals are rarely found in a pure state, but are generally combined with earthy matter. In that condition they are said by miners to be in the state of "ore." Gold you know to be of a yellow

colour, and used in this country for money, jewellery, and other ornamental purposes; but being rather soft, it is generally mixed with a little silver or copper, which alloy considerably hardens it and changes its natural colour. It can be drawn into wire of extreme fineness, and beaten into leaves thin enough to be blown away by the slightest wind. The ductility* of gold is such that one ounce of it is sufficient to gild a silver wire that would reach from here to Rome. Gold is seldom found perfectly pure,

* "Ductility" means that adhesive property which some metals possess, of being drawn out into wire without breaking.

When any substance is separated or broken, it is philosophically speaking, the attraction of cohesion which is overcome in that particular part.

but usually mixed with silver, copper and other metals. Most of the gold of commerce is at present brought from mines in Africa and America; it occurs however in some quantity in Hungary, and the Ural Mountains in Russia. This "ore" is deposited by nature in soft sandstone, more frequently in small grains about the size of grains of sand; these rocks being worn away by the action of the weather, the sand produced from them (containing also the golden grains) is washed by the rain, &c. into the neighbouring rivulets and streams: the currents carrying away the mud and finest parts of the sand. The gold-washers go into the stream up to their knees, with a vessel like a quart basin, and take it up about one

third full of sand, and the remaining part of the basin nearly full of water, then with their fingers they whirl the contents round and round rapidly, so as to get all floating together—the grains of gold being considerably heavier than the sand, will sink before the sand has time to settle, which with the water is then rapidly poured away. After repeating this process several times with fresh water, they see if there be any grains of gold left at the bottom of the basin. You can easily try this experiment, by using small lead shot as a substitute for the gold.

The metals are separated from their ores by various means, such as washing, melting, &c.; the method must always be regulated by the

nature of the ore to be purified. A substance is added to the ore when pounded, that is known to have an affinity (chemical attraction) for the metal it contains; with this, on the application of heat, it unites, and leaves the residue in a state to be more readily separated. The metal and its fickle friend only remain together until another opportunity is offered for the latter to escape, either by evaporation, or by being brought in contact with something it likes better, and the gold is then left perfectly pure.

Silver is found in various parts of the world, particularly in Peru and Mexico, in Saxony, Norway, Sweden, Russia and Siberia. A considerable quantity has also been obtained from

some of the lead mines in Great Britain and Ireland. Silver usually contains other metals; in separating which, the refiner is generally amply remunerated by the small portion of gold he finds mixed with it. This he reserves for himself, returning to his employer the whole amount of pure silver, as well as the copper it contained.

Silver is the whitest of all metals, only moderately hard: it may be beaten into leaves much thinner than paper, and drawn into wire as fine as a hair without breaking. It is chiefly used for ornamental work, for domestic utensils, and for money; but for these purposes it is usually mixed with a small quantity of copper, which gives it more firmness.

Copper is found in several parts of England and Wales, particularly in Cornwall and the Isles of Man and Anglesea ; it is an abundant metal, and has been raised in various parts of the world. It can be beaten into sheets, and drawn into wire similar to gold and silver, but not so thin. The uses of this metal are too many for us to enumerate. Besides making boilers for steam engines, and other large vessels, it is used for covering the bottoms of ships, in order to preserve the timber ; also, reduced by chemical combination, it is very serviceable for painting and dyeing, most beautiful green pigments being produced from it. Copper mixed with zinc forms brass, or with tin, bronze. It is necessary to be ex-

ceedingly careful in keeping copper saucepans, and other vessels made of this material, perfectly clean. There is no danger while the fat oily substances are hot, it is only when allowed to cool therein that they imbibe a poisonous quality; the same care should be observed with respect to acids; some cooks prefer making pickles in copper or brass saucepans because it contributes to their green appearance, at the same time disregarding its noxious qualities.

I have said more of these three metals, gold, silver and copper, than I should have done, were they not employed in that all-important article money: otherwise there are several to which we are more indebted for the comforts of life, especially iron,

perhaps the metal most indispensable to our wants, and fortunately the most abundant in nature. We cannot look around us without iron meeting our eye in some shape or other; it has been more or less employed in every article we use, either in the state of wrought iron, cast iron, or steel. It gives fire on striking with flint (this was the usual method of getting a light before lucifers were invented), and is the cause of the redness in common bricks; it gives colour to the cornelian, garnet, and other precious stones, according to the different proportions in which it is mixed with oxygen, and is also found, as I said before, in our blood, and in many plants; it is likewise most important and valuable in the

arts, being used in painting, ènamelling, dyeing and medicine. The heat which is necessary for the separation of iron from the ore is so intense, that we cannot wonder at many nations remaining long entirely ignorant of its use, and even of its existence. To melt iron requires about twenty times the heat necessary to make it red hot in a common fire.

Good edge-tools cannot be made without steel, which is nothing more than pure soft iron combined with a small portion of carbon, and probably silex (flint) and phosphorus. The best penknives, scissars, razors, fine saws, surgical instruments, and every kind of edge-tool which requires a fine polish, or is used by the most ingenious artisans, together with a

great variety of implements in cutting and working iron, are now made of cast steel.

Platinum is a metal which perhaps you have never before heard mentioned. It has only been discovered about a hundred years, and usefully applied half that time. It is not very abundant, is found in grains, also mixed with other metals, and in the state of ore. It is the heaviest substance with which we are acquainted, being about twice as heavy as lead, and is nearly as white, but not so brilliant as silver. It can also be beaten into sheets and drawn into wire. Platina requires the strongest heat of our furnaces before it will melt, and remains unaltered by most acids and salts that destroy other

metals; for this reason it is highly valuable to chemists for experimental purposes; they make all sorts of little vessels, cups, small tongs, rods, and spoons of it; for the latter it is especially well calculated, because the heat does not run up the handles as it would if any other metal were placed with one end in a boiling liquid or intense fire; all bodies which slowly convey the heat thus applied throughout their entire mass, we call "bad" or "non-conductors" of heat, and on the contrary, those which become quickly affected by it, we term "good conductors." You have often startled on handling a silver spoon that has been left in very hot tea. Silver is a "good conductor." In the manufacture of tea

and coffee pots of that metal, those of the most expensive kind generally have silver handles, which would become too hot for the delicate hand of a lady, were not the connexion intercepted by a little piece of white wood or ivory, above and below the handle, just where it is fastened to the body of the vessel. You also know what a warm thing we consider flannel to be, and all woollen clothes; flannel is not warm in itself, but being a bad conductor of heat, it does not readily allow the warmth to pass away from our bodies. Wood and most other porous or spongy substances are all "bad conductors," so are wool, hair, and feathers: thus it seems the intention of the good and wise God so to protect many of

his creatures which are exposed to cold, and unable to obtain sufficient shelter. The furs of all animals are thicker and longer in winter than in summer, and those which live in the frozen regions, such as the polar bears, have more hair than any of the same species elsewhere. To whatever object in nature we turn our attention, we find the wisdom and superintending power of the Deity; in each animal and plant, whether it be placed on earth, in water, or in air, in scorching sun or in the frigid zone, there may we trace His perfect laws, fitting each to its position and station in the world. The provision of the Almighty for his creatures is again exceedingly remarkable in the differ-

ence between the plumage of land and water fowls ; nothing looks more wretched or deplorable than cocks and hens in a shower of rain, yet the duck will dive to the bottom of a pond, and return to the surface as free from wet as if she had been sitting in a bandbox : a sufficient quantity of oil, and only just enough, is secreted and diffused through every feather to repel the wet, and the water runs off her back in little drops, leaving the feathers as fresh as ever.

With platinum I must take my leave of the metals ; it would become tedious were I even to tell you their names, for chemists reckon forty-two, each possessing some properties distinct from *the other*.

CHAPTER VI.

Besides the metals, I mentioned two other substances, carbon and silicium, which are amongst the component parts of our globe, the former is known quite pure only in the diamond; when carbon is united to a certain quantity of oxygen, it forms what we call carbonic acid; it also mixes with other gases, and with each in several fixed quantities, forming, as you may suppose, different substances accordingly. How a gas manages to creep into what we look upon as a dense solid substance, I must explain another time.

We are all able to obtain charcoal tolerably pure, but no one has at present been able to crystallize it into the diamond. It is nature alone that can do this. Diamonds have no brilliancy when dug out of the ground, but are covered with an earthy crust, being usually found in a yellow ocherous soil. They are likewise met with detached in torrents which have carried them away from their beds; they are found in considerable numbers in the island of Borneo; whenever the mines are searched for them, an overseer attends to prevent the workmen purloining them, but notwithstanding this precaution the men frequently contrive to convey them away se-

cretly, and will, for this purpose, sometimes even swallow them.

Carbon forms the greatest portion of all vegetables, not only in their woody fibre, but is a component part of their sugar, wax, oils, gums, and resins. As a simple substance it is one of the most unchangeable things with which we are acquainted; neither air, water, nor any other substance found in nature, has any action upon it (except at very high temperatures), though it has more or less effect upon every production of the earth. In consequence of its durability the lower part of posts intended to be driven into the ground are frequently charred*; the coat of

* Or partially burned, so as to form charcoal on the surface.

charcoal thus formed protects the uncharred portion of the wood from decay.

It has been discovered that the air which has been changed by the breath of animals is peculiarly suited for vegetables; this is no doubt owing to our breath containing carbon, which the vegetables immediately appropriate to themselves, and they in their turn supply oxygen for our respiration. How full of wisdom do all these regulations appear! and how dependent upon one another, and inseparable, are the three kingdoms of nature! That the vegetable should require the very material we reject, and which if allowed to remain in our atmosphere would act as poison to destroy our life! and that we

should be equally indebted to vegetables for the formation of the very gas* which is necessary to our respiration!

Silica is placed by chemists under the class of "earths," so called because they are the principal ingredients that form the soil in which plants grow. It forms a number of different stones, being in fact an essential ingredient of the greater number of hard-grained stones with which we are acquainted. Silica (or silex, which is the Latin word for flint) is one of the most abundant materials in nature, and forms a large portion of our rocks, especially those of a granitic kind. Every country, and every district in the world, affords

* Oxygen.

examples of it. The milk-white varieties with the beautiful play of colours, are named precious opal; when of a purple colour it is called amethyst; of a yellow colour, topaz; the colour depending upon the different proportions of iron with which it is mixed; the transparent crystallized varieties called "rock crystal," the grey, brown and black, which occur in curious shapes, principally in chalk rocks, we term flints; it is quite insoluble in water, and unacted upon by air; in fact the chemist has very little power over it alone, but when he adds pearl-ash or soda, and pounds it very fine, he can then dissolve it by applying heat, and together they form the clear, transparent substance which we know as glass.

Common glass always contains other matter, but the basis of all good glass is this mixture of flint and soda.

I have told you that silica is found in many plants, such for example as corn and grasses, the stalks of which mainly derive the strength which enables them to grow erect from the silica they contain.

Plants derive this material from the soil, which they can only absorb at their roots when it has been dissolved in water which it finds in the ground, for rain water contains no earthy matter. Its quantity varies in different plants; Dutch rushes contain even more than hay or straw, and cane contains so much that it appears completely coated with flint.

Although the ingenuity of man

cannot dissolve flint in water, the Almighty, by some wonderful and to us unknown process, performs this operation even copiously, as I described to you (page 13) the Geysers of Iceland, which must be regarded with astonishment!

Of all the substances which have either replaced or covered once-living forms,* flint affords us the most beautiful and instructive examples; it can insinuate itself into the smallest pores, and we find the structure both of animal and vegetable matter more faithfully shewn in this material than in any other; shells, previously to their being imbedded in sands or rocks, are frequently pierced in various directions by other creatures

* Called also "organic matter."

that live upon them; these holes, which you may frequently find in the common oyster, afford an easy access to the flinty liquid, which can also percolate or pierce through what you would consider quite a close stone. I can shew you several specimens of this, which form both wonderful and beautiful curiosities of nature.

Sulphur, or brimstone as it is sometimes called, is found in most parts of the world, combined with the metals from which it is separated by what is termed "roasting." It is obtained in the greatest abundance from iron pyrites, which is heated in an oven so constructed that the sulphur, which is driven off in the state of vapour from the pyrites, on being cooled in a different part of the oven,

forms a powder, which adheres to the sides of the chamber, as soot does in a chimney, and is in this state easily collected, melted, and formed into sticks or rolls.

Sulphur is ejected from those burning mountains called volcanoes, and is found in many mineral waters, combined with a gas called hydrogen; also in cresses, horse radish, and several other vegetables. It very readily takes fire, for which reason the ends of matches are tipped with it; it burns with a blue flame, and gives out a disagreeable suffocating smell. One of the many uses of sulphur is for bleaching; this property you can try yourselves by holding a lighted match or piece of burning brimstone near a blue flower, its

colour will soon completely disappear.

Iron pyrites is frequently dispersed in the form of little shining particles throughout coal ; this is highly objectionable for manufacturing purposes, not only on account of the nauseous smell which arises from it while burning, but its fumes do great mischief in many operations connected with the Arts, and consequently coal containing it cannot be employed ; it is so difficult to expel the whole of the sulphur from coal, that even when reduced to coke there still remains enough to be troublesome in such operations.

Sulphur is required in large quantities for making gunpowder ; it is also considerably employed in medi-

cine, penetrating as it does the most minute vessels in our system.

I will close these pages with a short account of common salt, leaving you to consider the many wonderful things I have mentioned.

Common salt is found in a solid state as rock salt, or is obtained from boiling sea or salt spring water, either by evaporating it over a fire, or exposing it to the rays of the sun. It is supposed that brine springs are formed by a stream of water flowing through a stratum of rock salt, and that these salt rocks are composed of deposits from salt lakes or seas, which are now dried up. There are some very celebrated mines of this material near Cracow, in Poland, which have been excavated with so

much regularity and beauty that they are visited by travellers as one of the greatest curiosities in the world: 800 workmen are constantly employed in digging salt and raising it from the depth of 450 feet to the earth's surface.

These mines are immensely large and perfectly dry: at each end is a chapel, hewn out of the salt, for the use of the workpeople, most of whom entirely live in these mines. The images which adorn the altars, as well as the pillars and ornaments, are carved out of the solid mass, and the light from the torches glittering on the salt produces an effect both novel and beautiful. Descending still lower into the earth, there is an immense hall or cavern of salt, in which a

thousand persons might dine together without inconvenience. It is a curious fact, that a stream of pure fresh transparent water flows through these mines, which almost seems provided by nature for the express purpose of refreshing the workmen and horses therein employed; this spring filters through a bed of clay, sufficiently thick to protect the water from the action of the salt, a small quantity of which would render the whole perfectly useless for this purpose.

Salt rocks and strata are found in all parts of the world. In England the great depositories of this material are in Cheshire and Worcestershire, where are also the brine springs before mentioned.

Salt is not only met with under ground, but also exists at great elevations. In Caubul, in Persia, a road is cut through a mass of rock salt that rises in a cliff more than a hundred feet above the river,* and in Abyssinia there is an immense plain of salt, to cross which would occupy the traveller four days!

The uses of salt are numerous, but the quality which renders it so indispensable to us, is its use when mixed with our food. In countries where salt is scarce, the want of it is severely felt in the animal kingdom.

* This must not be mistaken for a mountain consisting entirely of salt, as, if that had ever been the case, the wet or damp would long ere this have levelled it with the ground. The mountain here mentioned probably contains exceedingly thick strata of salt running through it, but is most likely surmounted with earth of some kind.

In the middle of Africa, on account of its scarcity, mothers give their children a lump to suck now and then, for a treat, as I give you barley sugar.

In the States of La Plata, in South America, the sheep and cattle, when they discover a pit of salt clay, rush so eagerly to feed upon it, that in the struggle many are trodden to death! In Upper Canada there is so much wild pasture in the woods that the cattle stray far from home to browse, but such is the force of instinct bestowed on them by the great Creator, that they return regularly once a week to the farms of their respective owners, in order to procure a little salt, which they find either mixed with their fodder, or

spread over posts placed there for them to lick; having satisfied themselves they return to the woods, and were it not for this attraction they would probably wander so far as to be lost to their respective owners.

Salt is of more importance to the animal frame than most persons imagine; it is no doubt regarded by general consumers merely as a relish to their food, but its solvent property materially assists digestion, and ought therefore always to be eaten in moderation.

Some idea of the structure of the earth, as well as of the chemical characters and uses of its various compounds, is highly advantageous, particularly to those employed in mining operations, when searching

for coal, salt, metallic veins, or springs; it prevents many ruinous speculations to which ignorant persons are frequently subjected. In excavating for the purpose of forming canals, tunnels and railroads, operations which are now going on in almost every part of the civilized world, a knowledge of geology is indispensably necessary.

Through the medium of this science we may also trace many circumstances respecting the ancient history of the globe; we may read, with more truth than in a book, of the commotions of nature—the various contentions of land and water to gain supremacy, the important revolutions worked by the great stores of subterranean heat, which

laid the foundation of our primitive rocks; these again have been rent, and a newer melted matter of the same character ejected through the openings, which have also in many places been filled in with metals.

Granite, which is called the basis rock of the earth, although of many varieties, is of hard texture and crystalline appearance; over it, other rocks are formed in sheets or strata, with the appearance of having been originally deposited by sediment in water.

Nor have *these* rocks been allowed to remain at rest, the internal heat in many instances has again sent forth the granite, volcanically and confusedly at various times, hoisting them out of their levels. The pre-

sent admirable arrangement of rocks is a consequence of the numerous upheavings and sinkings to which the earth's surface has always been subjected. By this means we not only obtain easy access to the different deposits, which to us are the sources of industry and wealth, but what is of equal importance, we find them distributed in different districts, thus affording varied employment to our fellow creatures in every corner of the earth. Such dislocations and convulsions consequently are of the utmost benefit, and but for them the earth would have been quite uninhabitable, for neither plants nor animals could have existed, had its surface presented only one unvaried mass of granite or lava, and the

intermixtures of limestone, clay and sandstone, been buried beneath them, which under the present arrangements are so advantageously distributed.

There is abundant evidence to shew that the earliest rocks, which are destitute of organic remains, were formed first under the influence of fire, and afterwards decomposed by water,—those two universal and contending powers, which man has also made subservient to his mechanical, chemical and culinary operations.

The orders of rocks next appearing are various, and in them animal remains for the first time appear, and gradually become more abundant and of a higher class, as they advance from the older to the newer series,

thus the most ancient rocks of the secondary formations enclose zoophytes and shells ; the next in order contain, in addition, vegetable remains and fishes; those which succeed, envelope not only shells, fishes, zoophytes and plants, but also bones of enormous reptiles—the earth not being as yet sufficiently advanced in tranquillity to admit of general occupation by warm-blooded terrestrial animals.

In these rocks, which are called the secondary, in the tertiary, and in the successive formations, Nature has laid up her store of riches ; not riches intrinsically speaking, but such as afford the inquiring mind undeniable evidence of the order of creation. Here, as on the coins placed

by builders in the foundation stone of our temples and palaces, we may read the indelible inscriptions of their species, form and date, giving a sort of history of the organic departments of nature from perhaps near the beginning to this very time.

This interesting and instructive study has hitherto engaged with zeal and industry the attention of but few individuals, and that principally during the last half century; they have rendered it however a comparatively easy task for others who desire to follow their footsteps into the beautiful science of geology. With the aid of their excellent books, which contain a mass of valuable information, as well as carefully delineated examples of the nature and

extent of strata, with their accompanying treasures, we may descend with them into the depths of the earth, travel around it, and over its loftiest mountains. Whilst sitting in our easy chair, we may thus be introduced into islands and continents that have been buried for ages beneath the ocean, and different races of extinct animals and plants will thus vividly be made to appear before us ; and should we then even wish to see some of the realities, how highly gratified may our curiosity be by visiting that magnificent public repository, the British Museum : there we may freely contemplate the extensive series of rock specimens, minerals and fossil organic remains, which submit to the inquiring mind of man

the history of thousands of ages which preceded the existence of his race, and of thousands of animals that never were contemporaneous with his species.

The inhabitants of the earth have ever been divided into the two great classes I have already mentioned—the herbivorous and carnivorous. It may at first sight appear inconsistent with benevolence that one creature should be allowed to prey upon another, but upon reflection we may pronounce it a very wise dispensation, for were this not the case, the herbivora would multiply to an extent greatly exceeding their supply of food. (See Buckland's Bridgewater Treatise.)

We find in the order of creation that the food was always provided in

readiness for the animal that it was destined to support: thus vegetables had increased to an enormous extent before insects and larger animals were called into existence to feed upon them; the lion was not created before the lamb, nor the lamb before the herbage most grateful to its palate, thereby evincing a decided preparation and completion throughout the whole arrangement; each creation depending on that which preceded it, and thus we find that human beings, who are creatures of the most varied wants, were not made until all was completed over which they were to have dominion: we have not only the authority of the Bible for this, but all the evidence collected by geologists upon the sub-

ject affirms the total absence of any vestiges of the human species throughout the entire series of geological formations. Human bones, with works of art, have been discovered imbedded in solid stone, but there is no reason to believe them to be of high antiquity, as in the first place, the bones retain a large quantity of animal matter and the whole of their phosphate of lime; and secondly the rocks in which they occur, are proved to be of very recent formation, composed of fragments of corals and shells which inhabit the adjacent waters. Such kind of stone is frequently formed in a few years from sand banks composed of similar materials on the shores of tropical seas.

The different stages of fossilization

in which we find various organic remains depend upon the time that they have lain subjected to such influence: there are the bones of an enormous reptile in the British Museum, called the iguanodon, which were found in Kent, about 15 years ago, embedded in one of the tertiary rocks; these exhibit the total conversion of bone into mineral matter. I have a portion of a tree which is also completely fossilized, it was taken from the "Dirt-bed" Isle of Portland. This, so called, curious deposit, is a horizontal layer of mould, about a foot thick, situated between those limestone rocks which are known as Portland stone; it contains many of the trees and plants still standing erect, having their roots in

the soil, and their trunks extending into the upper limestone, as if petrified while growing undisturbed in their native forests: so completely has flinty material and limestone taken the place of the delicate vegetable matter, that upon striking a fragment of it against steel, it emits sparks.

Here then are two examples of complete transformation: what mighty intervals of time such changes occupied no one can possibly tell, but all geologists agree that these individual species were amongst the early inhabitants of the globe, their stony forms being imprisoned in rocks of very ancient date. Examples of organic remains *partially* fossilized, may be produced from more recent

rocks, consequently we may infer that it takes vast periods of time to complete the process.

It seems difficult to form any idea of the immensity of *time:* time and space completely baffle the comprehension of man. On examining the mere shell of the earth, our thoughts are naturally led to an unknown series of ages in which creation appears to have followed creation at the distance of mighty intervals. On imagining a beginning of time, the question naturally suggests itself, What happened before then? and the same thing may be said with regard to *space;* if the mind pictures a limit to it, What is there beyond that limit?

We have perhaps a clearer conception of the incomprehensibility of

space, since the improvement of telescopes, which teach us that beyond all that is visible to man, there may lie fields of creation which sweep immeasurably along, and carry the impress of the Almighty's hand to further and more distant scenes of the universe. It tells us that this mighty globe is but as an atom of dust in space, and that there are worlds as numberless, as are the glories of the firmament; but to this world, though it be as a speck in the universe, doth the Lord vouchsafe his constant care.

You have heard of the formation and dispersion of a few of its valuable products, the relative quantities in which they are distributed, and how accessible they are to man if he search for them aright. I have shewn you

how plentiful are those metals which are most useful, and the comparative scantiness of others which are less so; of the facility of separating those metals from the ores with which they are found united; also of the benevolent provision of almost inexhaustible stores of salt and fuel, to supply the wants and reward the industry of man in these latter ages of the world; how the vast repositories of coal accumulated from the wreck and ruins of disturbances that affected our planet long before the existence of the human race: in all these, and a thousand other examples, we may trace the wisdom and consideration of the Almighty in providing for the wants of its inhabitants, not only at the moment when he laid the first

foundations of the earth, but also through the long series of shocks and convulsions which he has since caused to pass over it.

It has been my object in the preceding pages to select a few subjects to excite, rather than satisfy a rational curiosity to investigate the works of nature, in hopes of promoting a taste for philosophical inquiry, and of encouraging a further anxiety to dive into those noble investigations of scientific men, the results of which have added so much to our happiness and comfort.

The earth, the air, and the water all teem with objects of interest and admiration, and it is a high privilege to be endowed with reasoning faculties capable of contemplating and

appreciating such perfect works. Do not suppose however that this beautiful world was created *solely* and *exclusively* for the enjoyment and admiration of man: no, we may reckon the advantages he derives from his position upon it, as a necessary consequence of its perfection, though we may at the same time believe, that these advantages were all foreseen and comprehended in the plans of the great Architect of that globe, which was destined to become, at the appointed time, the scene of human habitation. "By applying ourselves to the study of nature, we daily find more and more uses in things that at first sight appeared useless. But some things are of such a kind as not to admit of being ap-

plied to the benefit of man, and others are too noble for us to claim the sole use of them. Man has no farther concern with this earth than a few fathoms beneath his feet: was then the whole solid globe made only for a foundation to support the slender shell he treads upon? Do the magnetic effluvia course incessantly over land and sea, only to turn here and there a mariner's compass? Are those immense bodies, the fixed stars, hung up for nothing but to twinkle in our eyes by night, or to find employment for a few astronomers? Surely he must have an overweening conceit of man's importance, who can imagine this stupendous frame of the universe made for him alone. Nevertheless, we may so far acknowledge all things

made for man as that his uses are regarded conjointly with those of other creatures, and that he has an interest in everything reaching his notice, and contributing either to the support of his body, or the improvement and entertainment of his mind. The satellites that turn the night of Jupiter into day, assist man in ascertaining the longitude, and measuring the velocity of light: the mighty sun, that like a giant holds the planets and comets in their orbits, enlightens him with its splendour, and cherishes him with its warmth: the distant stars, whose attraction probably confines other planets within their vortices, direct his course over the boundless sea and the inhospitable desert."*

I hope you will remember a great

* Tucker's Light of Nature, book III. chap. ix. p. 9.

deal that I have said, for it is sure some day or other to be found useful; it will also afford us plenty of conversation at the approaching winter's fire-side, and be the cause of a thousand fresh subjects of inquiry, which will keep your thoughts perpetually on the wing, and thus that weariness of mind, which is one of the greatest enemies to a happy disposition, will never be experienced, and the craving after frivolous and unworthy pursuits will be superseded by an inexhaustible source of pure and pleasing contemplation, which may be enjoyed in every situation in which you are placed, and which will tend to make you useful and respected members of society, besides ensuring you the love and esteem of your best friends.

Fortunately for us there is something in our nature which prompts us to rejoice in the contemplation of the works of God, and causes us to take delight in their development. "Nowhere throughout the whole creation is the goodness of the Almighty more conspicuous than in the means he has provided for revealing himself to his intelligent creatures, by conferring upon them these very powers of discovering truth, and appreciating its beauty and loveliness."* And fortunately again is it for us, that we live at a time and in a country in which these studies are not only allowed, but encouraged; and those who have made the greatest advances in science and learning, are amongst

* Fownes's Actonian Prize Essay, page 157.

those who are most admired, beloved and respected by all who have the pleasure of their acquaintance.

In the days of the old philosophers, many of those who made the most important discoveries, if they even escaped the punishment of death, had not only the mortification of seeing their writings burned, but were themselves either cast into prison, or driven with indignation from their native country, unless they would consent to declare publicly all their assertions to be false. The people at that time were so ignorant as to imagine that these wise men were either bewitched, or were provoking the anger of the Almighty by diving too deeply into the mysteries of his wondrous works; not under-

standing that it is science alone which lights the way "through nature up to nature's God." Now, the most humble individual who adds his mite to the general stock of information is regarded with honour and esteem.

And what is life without the refreshing draught of knowledge? Truly as insipid as the richest dish without salt! It is an accumulation of good things requiring that relish to give each its proper flavour. 'Tis indeed knowledge that develops our good sense, and that sense properly directed materially assists us in discharging, with credit, the important duties of matured life: it secures to old age those pleasures which, are sought for in vain amongst the gay and busy scenes that in early life en-

grossed our attention. As the effects of a richer soil, and other genial circumstances, cause flowers, which in a state of nature never present more than a single row of petals, to assume several rows under continued cultivation; so likewise do the moral and intellectual powers of man become enriched by continued cultivation, and present human nature in its most sublime and exalted form!

But do not suppose, while I speak thus gravely on this important subject, that I would banish all the hilarity and joyousness of youth, and have you demure, sage old people instead of lively, prattling, sensible children. You may dance, and sing, and play besides all this: I only wish that you may not walk blindfold

through this beautiful world, heedless of the wonders by which you are surrounded, and that when a few young friends meet to enjoy your society, you may have something more to talk about, than so many Turks, who sit smoking their long pipes together, and at the end of every half-hour say "How d'ye do?" because they have nothing else to talk about.

I wish you also to bear in mind (as a check upon displaying any little knowledge you may possess above your companions) a very good remark made by a sensible man who wrote a great many clever books; he says in one of them, "Use your knowledge as you would a watch, when it is wanted, and do not pull it out for

display on all occasions." There is always sufficient demand for it in the common every-day concerns of life, and it is wonderful to observe, how very much our happiness depends upon its application: it is not only necessary to the philosopher, but is useful in the laundry, the kitchen and the drawing-room. There is no individual, however humble or elevated his position in life, but would be benefited by an increased knowledge of those perfect and general laws which govern every portion of the universe; nor is there a subject too trifling, or too insignificant for the most learned to reflect upon, or a science, properly investigated, but points with the greatest certainty to the fact, that all things have been

framed and fitted to each other by a divine and intelligent mind. It is not the heavens alone which declare the glory of God; nor the boundless starry firmament only, which sheweth his wondrous works. His omnipotence, his wisdom, his superintending providence are equally manifest in the hyssop that grows on the wall, as in the majestic cedar of Lebanon; nor more in the sapient elephant than in the meanest worm that creepeth on the earth, or the animalculæ that human eye can only detect with microscopic aid; in the huge leviathan of the deep, than in the lowest of the radiated tribes that slumber in the coral caves of the ocean!

> "If these thy works so great,
> How great art thou, O Lord!"

INDEX.

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